



Accelerating Innovation With Generative AI: AI-Augmented Digital Prototyping and Innovation Methods

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Abstract—Easy-to-use generative artificial intelligence (AI) is democratizing the use of AI in innovation management and may significantly change the way how we work and innovate. In this article, we show how large language models (LLMs), such as generative pretrained transformer (GPT), can augment the early phases of innovation, in particular, exploration, ideation, and digital prototyping. Drawing on six months of experimenting with LLMs in internal and client innovation projects, we share first-hand experiences and concrete examples of AI-assisted approaches. The article highlights a large variety of use cases for generative AI ranging from user journey mapping to idea generation and prototyping and foreshadows the promising role LLMs may play in future knowledge management systems. Moreover, we argue that generative AI may become a game changer in early prototyping as the delegation of tasks to an artificial agent can result in faster iterations and reduced costs. Our experiences also provide insights into how human innovation teams purposively and effectively interact with AIs and integrate them into their workflows.

Key words: AI-augmented innovation management, artificial intelligence (AI), digital prototyping, generative AI, idea generation, innovation, large language model (LLM), need identification, no-code prototyping, UX/UI

I. DEMOCRATIZATION OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI) IN INNOVATION

GENERATIVE artificial intelligence (AI) based on transformer machine learning models, such as generative pretrained transformer (GPT) and its chatbot application ChatGPT, is easy to use and accessible to end-users. This has democratized the use of AI, as machine learning was previously limited to a small group of skilled software engineers. Large language models (LLMs) are general-purpose technologies, and their versatility allows them to be applied in diverse scenarios. Pretrained LLMs are now so powerful that they often outperform models specifically trained for a particular use case, eliminating the

need for creating labeled training data. We are witnessing an unprecedented global phenomenon of end-users and employees experimenting with AI to boost productivity.

Historically, AI has been deemed suitable for analytical tasks [1], [2]. Creative and generative tasks, however, were thought to be reserved for the beautiful minds of human beings. A study conducted among innovation managers a few months before the barnstorming rise of GPT-3 in the last quarter of 2022 revealed that the idea generation, idea evaluation, and prototyping were considered the least important areas for AI application in the innovation process [3]. Within months, the emergence of transformer language models and generative AIs has changed this perception, and the use

of AI in creative tasks, such as idea generation, has moved to the center of attention of both practitioners and academics [4], [5], [6].

Despite the hype about and widespread experimentation with ChatGPT, research on the use of generative AIs in the corporate world is still scarce. This article aims to shed light on how LLMs can enhance innovation activities within companies. Over the past six months, we have experimented intensively with generative AIs in the context of innovation. Our experiences are based on both internal development of innovation methods and external projects with clients. Specifically, we want to provide insights into specific use cases of LLMs, such as ChatGPT, in the early phases of innovation, i.e., exploration, ideation, and prototyping. While we share a brief overview of the use cases for LLMs in the first two phases, our focus will be on AI-augmented prototyping of digital products. While LLMs can improve and accelerate the process of exploration and ideation, they add an entirely new capability to nontechnical individuals that do not have any software skills. LLMs can operate as a text-to-code generator empowering users to embrace early prototyping without writing code themselves. Users simply describe the digital product (e.g., a website) in natural language, which the LLM then turns into programming code (e.g., HTML code). This puts nontechnical users in a position to close the gap between conceptual work (i.e., ideas and concepts) and early look- and feel-like prototypes that can be tested with users.

II. AI-AUGMENTED INNOVATION FRONT END

A. Exploration In the exploration phase of innovation projects, companies try to understand the context in which they intend to innovate and gather important impulses, e.g., get a deep

understanding of users, technologies, and regulatory forces to identify opportunities and potential threats. LLMs can support a variety of tasks in this phase (Table 1 showcases some ChatGPT use cases along the example of the automotive industry). Among others, general influencing factors in the environment of a company can be gathered asking ChatGPT to perform a PESTEL analysis (see use case 1 in Table 1). ChatGPT can also help innovation teams explore the user perspective. You can ask ChatGPT to list key challenges or needs users face in specific contexts or while using a certain product. This information is even more helpful and comprehensible when you ask ChatGPT to organize the challenges along a user journey and to create a table (see use case 2 in Table 1 for an example user journey “vacation by car”). To differentiate between different user segments, LLMs can generate an overview of user groups, such as performance enthusiasts, families, and luxury car buyers in the automotive context. Table 1 presents how user types can be brought to life by describing them as personas (see use case 3 in Table 1 for an example persona “performance enthusiast”). ChatGPT can also provide methodological support. For instance, it can generate a first draft of a customer interview structure, including typical agenda points and specific questions (see use case 4 in Table 1).

B. Ideation In the ideation phase, companies typically try to use creative techniques to generate ideas that address user needs and to make use of the stimuli collected in the exploration phase [7]. Working with ChatGPT, you can directly ask for ideas and specify your area of interest by adding a particular context, user segment, or user needs. In most cases, a prompt asking directly for ideas provides a very good overview of some of the key idea

areas; however, ideas usually appear to be a bit superficial and bland (see use case 5 in Table 1). Follow-up questions are a good strategy to enrich ideas and add details if the answer was not sufficient or satisfactory. For example, you can ask for a technology that could support the idea. Besides asking LLMs directly for ideas, you can also have ChatGPT apply creativity techniques, such as the SCAMPER method (acronym of Substitute, Combine, Adapt, Modify, Put, Eliminate, and Reverse) [8]. In our automotive case, ChatGPT suggested, for example, substituting the traditional car rental companies with peer-to-peer car-sharing platforms (see use case 6 in Table 1).

III. AI-AUGMENTED DIGITAL PROTOTYPING

Prototypes are designed to enable acceptance testing and concept validation with users after generating initial ideas and concepts. Software prototyping typically entails complex processes, including comprehending functionalities and customer needs, crafting seamless user journeys and designing wireframes and prototypes. Developing a high quality, lifelike click dummy in a UX/UI prototyping software, such as Figma, requires the collaboration of various professions and methods in a multiweek process. LLMs have the potential to accelerate the process from an idea to a (semi-) functional prototype. In this chapter, we illustrate possibilities for users with no technical background in prototyping to apply LLM functionality by going through a fictitious example of an automotive app.¹

An initial idea was generated by prompting “Suggest an innovative app for automotive.” In the answer, we received a suggested name

¹The example was created by using ChatGPT (Mar 23 Version) with GPT-4.

“AutoMate,” an overview of the app and a list of key features. To make the idea more concrete, we mapped the proposed features to a potential structure. We intentionally avoided using UX terms, such as “wireframe” or “information hierarchy” in our test, to explore possibilities for non-UX/UI-educated innovators. The output was

a table that outlines various sections (e.g., home screen) and the elements they could include (e.g., overview of app features). Next, we asked for advice to understand which design options to opt for and received an answer that follows the common patterns of a style guide by defining colors, typography, icons and

illustrations, imagery, layout, animations, and even a dark mode.

When trying to directly create a prototype by prompting “Create a prototype that I can open without installing anything,” we encountered an obstacle: Instead of generating code, we received the hint “As an AI

TABLE 1. Use Cases for ChatGPT in the Phases of Exploration and Ideation (Example Industry: Automotive).

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Phase / Use Case	Prompt	Output		
Exploration				
Use case 1: Environmental analysis (example: PESTEL analysis of automotive market)	Perform a PESTEL analysis of the automotive market. Create a table.	Sure, here is a table outlining the PESTEL analysis of the automotive market:		
		Factor	Description	Impact on Automotive Market
		Political	Government regulations and policies	Regulations on emissions, safety, and fuel efficiency can impact manufacturing costs and product design.
		Economic	Global economic conditions	Economic conditions can impact consumer demand for vehicles, as well as supply chain costs and production capacity.
		Socio-cultural	Changing consumer preferences and attitudes	Changes in consumer preferences, such as ride-sharing and subscription models, may impact traditional car ownership and sales.
		Technological	Advancements in automotive technology	Advancements in autonomous driving, electric vehicles, and connected car technology can create new opportunities for innovation and differentiation.
		Environmental	Sustainability and environmental concerns	Increasing awareness of climate change and environmental concerns can impact consumer demand for environmentally-friendly vehicles and regulations around emissions.
Use case 2: Need identification (example: user journey “vacation by car”)	Outline a general customer journey for a person going on vacation by car. Also highlight some common challenges customers face while using the car on vacation. Create a table.	Legal	Intellectual property laws and regulations	Protecting intellectual property and complying with regulations around safety and emissions can impact product development and manufacturing costs.
		Keep in mind that this is just a general analysis, and there may be other factors that could impact the automotive market as well. Additionally, different regions and markets may have unique factors that should be considered in a PESTEL analysis.		
		Sure, here’s a table outlining the general customer journey for a person going on vacation by car and some common challenges they may face:		
		Stage	Description	Challenges
		Pre-planning	Research and planning the trip	Choosing the best route, finding accommodations that offer parking, and ensuring the car is properly maintained for the journey.
		Departure	Leaving home and beginning the journey	Heavy traffic, road construction, and finding gas stations along the route.
		On the Road	Driving to the destination	Dealing with car troubles, staying alert and focused during long drives, and finding rest stops to take breaks.
Use case 2: Need identification (example: user journey “vacation by car”)	Outline a general customer journey for a person going on vacation by car. Also highlight some common challenges customers face while using the car on vacation. Create a table.	Arrival	Arriving at the destination	Finding parking, navigating unfamiliar roads, and unloading luggage from the car.
		During the vacation	Exploring and enjoying the destination	Finding parking near attractions, dealing with local traffic and parking rules, and keeping the car secure in unfamiliar areas.
		Return	Beginning the journey back home	Heavy traffic, finding gas stations along the route, and dealing with any car issues that may have arisen during the trip.
		Post-trip	Returning home and reflecting on the journey	Cleaning the car after the trip, addressing any maintenance issues that arose during the trip, and planning for future trips.
		Again, keep in mind that this is a general overview and there may be additional challenges or stages depending on the specifics of the trip and the customer’s individual needs.		

TABLE 1. (Continued)

Phase / Use Case	Prompt	Output
Use case 3: Persona creation (example: user type “performance enthusiast”)	Create a marketing persona for the user group “Performance Enthusiasts.”	<p>Sure! Here's an example marketing persona for the user group of performance enthusiasts:</p> <p>Name: Alex</p> <p>Demographics:</p> <ul style="list-style-type: none"> ● Age: 35–45 ● Gender: Male ● Occupation: Successful business owner ● Income: High <p>Psychographics:</p> <ul style="list-style-type: none"> ● Interests: Autoracing, high-performance vehicles, technology, luxury watches. ● Personality traits: Competitive, ambitious, tech-savvy, status-conscious. ● Values: Performance, innovation, quality, exclusivity. <p>Goals:</p> <ul style="list-style-type: none"> ● to own a high-performance car that delivers a thrilling driving experience and reflects his success and status; ● to stay on top of the latest advancements in automotive technology and performance; ● to connect with other performance enthusiasts and participate in track days and other automotive events. <p>Challenges:</p> <ul style="list-style-type: none"> ● finding the time to pursue his passion for high-performance cars while balancing work and family obligations; ● staying up-to-date with the latest automotive technology and advancements. <p>How BMW can appeal to this persona:</p> <ul style="list-style-type: none"> ● Emphasize the performance and technology features of their vehicles, such as turbocharged engines, advanced suspension systems, and cutting-edge driver assistance technologies. ● Highlight the exclusivity and status associated with owning a BMW, using language that speaks to Alex's desire to stand out and make a statement. ● Offer opportunities for Alex to connect with other performance enthusiasts, such as track days or BMW-sponsored events. ● Provide access to a range of customization options, allowing Alex to personalize his BMW and create a unique driving experience.
Use case 4: Method support (example: interview guideline)	Create an interview guideline for a 30 min customer interview to identify customer needs in the context of cars.	<p>Sure! Here's an interview guideline for a 30-min customer interview to identify customer needs in the context of cars:</p> <p>Introduction:</p> <ul style="list-style-type: none"> ● Introduce yourself and explain the purpose of the interview. ● Ask the customer to briefly describe their current car ownership situation, including the make and model of their current car. <p>Background:</p> <ul style="list-style-type: none"> ● Ask about their previous car ownership experiences, including any brands or models they have owned in the past. ● Ask about their primary use of their car (e.g., commuting, family transportation, leisure activities, etc.). <p>Features and benefits:</p> <ul style="list-style-type: none"> ● Ask about the features and benefits they value most in a car (e.g., safety, fuel efficiency, performance, technology, etc.). ● Ask about any specific features they would like to see in their next car. <p>Challenges and pain points:</p> <ul style="list-style-type: none"> ● Ask about any challenges or pain points they have experienced with their current or previous cars (e.g., maintenance issues, safety concerns, comfort, etc.). ● Ask if there are any features or benefits they feel are lacking in their current or previous cars. <p>Purchase decision:</p> <ul style="list-style-type: none"> ● Ask about their decision-making process when purchasing a car, including what factors they consider (e.g., price, safety, fuel efficiency, etc.). ● Ask if they have a preferred method for researching and comparing cars (e.g., online research, visiting dealerships, etc.). <p>Brand perception:</p> <ul style="list-style-type: none"> ● Ask about their perceptions of different car brands, including any associations they have with specific brands (e.g., luxury, reliability, performance, etc.). ● Ask about any brand loyalty they may have and what factors contribute to their loyalty. <p>Wrap-up:</p> <ul style="list-style-type: none"> ● Thank the customer for their time and valuable feedback. ● Ask if there are any final thoughts or feedback they would like to share. ● Reiterate that their feedback is valuable and will be used to improve the car buying experience.

TABLE 1. (Continued)

Phase / Use Case	Prompt	Output																								
Ideation																										
Use case 5: Idea generation	Act as if you were a participant of an idea-generation workshop. Create ideas for cars and related services that solve problems of customers who go on vacation by car.	<p>Great, here are some ideas for cars and related services that could solve problems for customers who go on vacation by car.</p> <ol style="list-style-type: none"> 1. Smart route planning: A car with an AI-powered navigation system that can plan the best route based on real-time traffic data and the driver's preferences, including scenic routes and popular tourist spots along the way. 2. Comfort and convenience: A car with a spacious and comfortable interior, equipped with features, such as adjustable seating, climate control, and ample storage space for luggage and travel gear. 3. Mobile charging stations: A network of mobile charging stations located at popular tourist destinations and along major highways, allowing the drivers of electric cars to charge their vehicles while on the go. 4. In-car entertainment: A car equipped with a high-quality entertainment system, including a large touchscreen display, premium sound system, and streaming services, to keep passengers entertained during long drives. 5. Safety features: A car with advanced safety features, such as collision avoidance systems, lane departure warnings, and blind-spot monitoring, to ensure a safe and stress-free driving experience. 6. On-demand car cleaning and maintenance services: A mobile service that comes to the driver's location and provides cleaning, detailing, and maintenance services for their car while they enjoy their vacation. 7. Car rental delivery and pickup services: A service that delivers a rental car to the customer's location and picks it up at the end of their vacation, eliminating the need for the customer to travel to a rental car office. 8. Mobile concierge services: A mobile concierge service that provides personalized recommendations for local attractions, dining options, and activities based on the customer's interests and preferences. 9. In-car food and beverage delivery: A service that allows customers to order food and beverages from local restaurants and have them delivered directly to their car, saving time and eliminating the need to search for restaurants while on vacation. 10. Car-sharing platforms: A car-sharing platform that allows car owners to rent out their vehicles to other travelers while they are not in use, providing an affordable and convenient option for those who prefer to rent from private individuals rather than traditional car rental companies. 																								
Use case 6: Idea generation (example: SCAMPER method)	Apply the SCAMPER method to create ideas for cars and related services that solve the problems of customers who go on vacation by car. Create a table.	<p>Certainly, here is a table applying the SCAMPER method to create ideas for cars and related services that solve the problems of customers who go on vacation by car:</p> <table> <tr> <th>SCAMPER Technique</th><th>Description</th><th>Example Idea</th></tr> <tr> <td>S - Substitute</td><td>Identify components of existing solutions that could be substituted with something new or different.</td><td>Substitute traditional car rental services with peer-to-peer car sharing platforms.</td></tr> <tr> <td>C - Combine</td><td>Combine two or more existing solutions to create a new solution.</td><td>Combine mobile concierge services with in-car entertainment to provide a more personalized and enjoyable travel experience.</td></tr> <tr> <td>A - Adapt</td><td>Adapt existing solutions to better fit the needs of customers.</td><td>Adapt electric car charging stations to be more mobile and accessible at popular tourist destinations.</td></tr> <tr> <td>M - Modify</td><td>Modify existing solutions to improve their functionality or performance.</td><td>Modify navigation systems to include real-time traffic data and scenic routes.</td></tr> <tr> <td>P - Put to Another Use</td><td>Consider alternative uses for existing solutions.</td><td>Use mobile car cleaning and maintenance services to provide customers with a convenient and hassle-free way to maintain their vehicles while on vacation.</td></tr> <tr> <td>E - Eliminate</td><td>Eliminate unnecessary or redundant components of existing solutions.</td><td>Eliminate the need for customers to physically go to a rental car office by providing delivery and pickup services for rental cars.</td></tr> <tr> <td>R - Reverse</td><td>Reverse the way existing solutions are typically used.</td><td>Reverse the way food and beverages are typically delivered by providing in-car delivery services from local restaurants.</td></tr> </table> <p>Using the SCAMPER method can help us generate a wide range of ideas by challenging us to think in different ways about the existing solutions and their components.</p>	SCAMPER Technique	Description	Example Idea	S - Substitute	Identify components of existing solutions that could be substituted with something new or different.	Substitute traditional car rental services with peer-to-peer car sharing platforms.	C - Combine	Combine two or more existing solutions to create a new solution.	Combine mobile concierge services with in-car entertainment to provide a more personalized and enjoyable travel experience.	A - Adapt	Adapt existing solutions to better fit the needs of customers.	Adapt electric car charging stations to be more mobile and accessible at popular tourist destinations.	M - Modify	Modify existing solutions to improve their functionality or performance.	Modify navigation systems to include real-time traffic data and scenic routes.	P - Put to Another Use	Consider alternative uses for existing solutions.	Use mobile car cleaning and maintenance services to provide customers with a convenient and hassle-free way to maintain their vehicles while on vacation.	E - Eliminate	Eliminate unnecessary or redundant components of existing solutions.	Eliminate the need for customers to physically go to a rental car office by providing delivery and pickup services for rental cars.	R - Reverse	Reverse the way existing solutions are typically used.	Reverse the way food and beverages are typically delivered by providing in-car delivery services from local restaurants.
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language model, I am unable to create an actual interactive prototype directly” and further advice on how to create a prototype using Figma or similar tools. To ensure the generated content was focused on creating a

basic web app instead of a Figma click dummy, we provided a specific prompt: “Guide me through the process of creating the code for a simple prototype that I can open with my browser.” This resulted in detailed instructions for creating a basic HTML/CSS prototype, with the generated code formatted and color coded according to the programming languages used. While the instructions did not require advanced knowledge, they did assume the reader was familiar with text editors, such as Notepad (preinstalled on Windows) or VS Code.

The generated website initially appeared to be very basic, with placeholder elements and headings. We then requested the addition of previously suggested features, resulting in a new iteration of the generated code and instructions for placement. After incorporating the suggested changes and extending the code, the prototype now featured three sections—“Smart maintenance,” “EcoDrive,” and “AutoAssist”—each with a brief

description and accompanying icon (see Fig. 1).

We realized that some features previously suggested were still missing, so we requested ChatGPT to include all suggested elements and noted that subpages could be added as well. This resulted in instructions for creating subpages and adding missing content. However, the advice for adding a navigation bar lacked specific placement instructions, so we asked for further details and received more specific instructions on where to place the provided code. ChatGPT recommended adding a dropdown menu to the main menu that linked to new pages featuring subfeatures. However, the now suggested subfeatures did not match the ones previously suggested. They were placed too long back in the conversation history and were, therefore, no longer taken into account.

Following the system’s previous advice to refine and improve the rather basic content and styling of the pages, we returned the task to

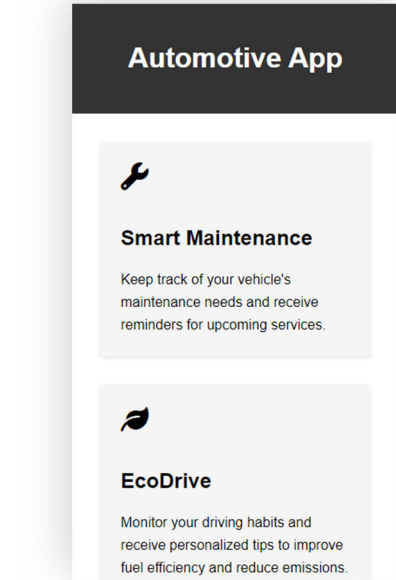


Fig. 1. Initially generated prototype.

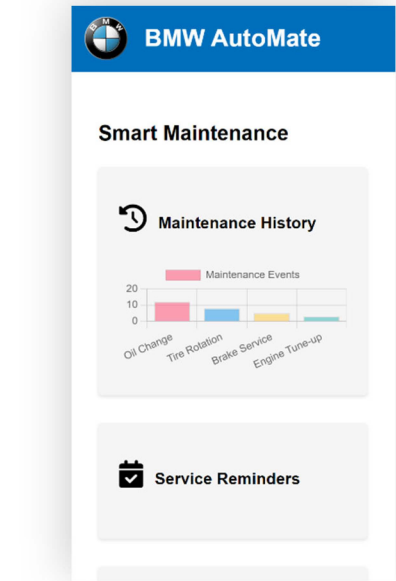


Fig. 2. Styled and elaborated feature subpage.

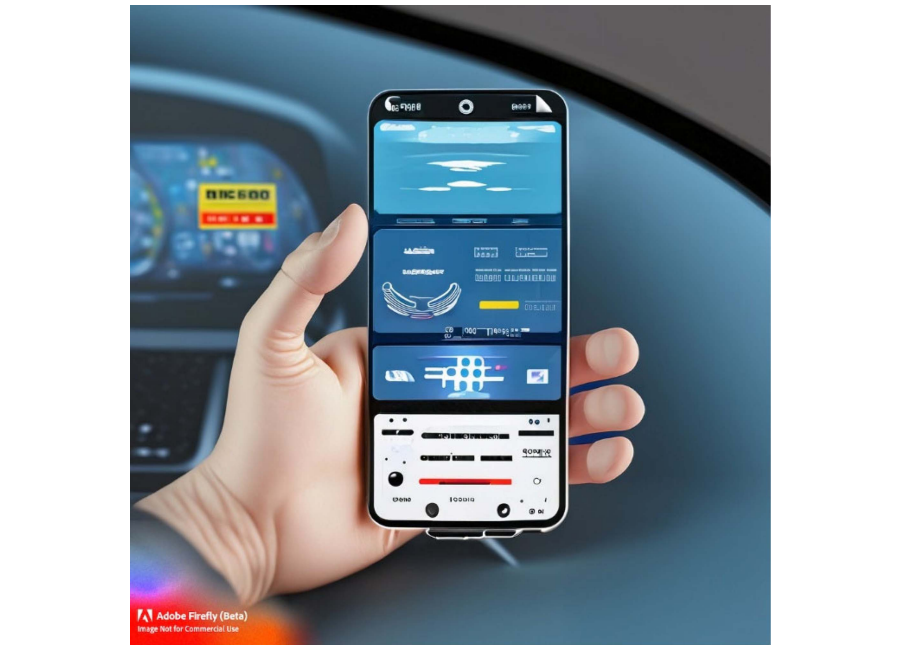


Fig. 3. Concept visualized by Adobe Firefly based on a ChatGPT-generated prompt.

ChatGPT and the generated code included comments indicating where additional functionality could be added. Additionally, the response suggested software libraries, such as Chart.js, for implementing functionality, providing instructions, and code snippets for rendering charts with exemplary maintenance events. We encountered a mistake in the suggested workflow that prevented the chart from rendering properly. We described the issue and received debugging support, eventually resolving the issue and rendering the chart correctly.

To adjust the app design, we requested specific suggestions for the brand BMW. The response included design elements, such as recommended colors (blue, white, and black), fonts, branding, and imagery advice. An updated code was then provided to apply these design suggestions. To simplify the process, we included the current code in our prompt and requested that the design changes be applied to it, along with a request to rework the header and add icons. The resulting app is shown in Fig. 2.

As a final experiment, we explored the potential of image-generating AI models. We asked ChatGPT for a suitable prompt, which was then fed into Adobe Firefly and iterated within the tool. The resulting output is shown in Fig. 3.

IV. DISCUSSION AND OUTLOOK

Our experimentation with LLMs in the early phases of innovation and

prototyping revealed three major insights.

First, there is a plethora of use cases ranging from user journey mapping to idea generation and prototyping. LLMs proved to be helpful in two regards: instruct users how to perform a certain task (e.g., methodological support for how to design an interview guideline) and apply knowledge and perform tasks themselves (e.g., direct question answering for needs along the user journey). This unique combination of capabilities foreshadows the promising role LLMs may play in future knowledge management systems once external sources can be tapped by LLMs.

Second, generative AI may be a game changer in early prototyping as the delegation of tasks to an artificial agent can result in faster iterations and reduced costs [9]. However, task definition, requirements, and workflow integration significantly influence the outcome. While the lack of expert input may limit the spectrum and quality of results, this approach allows users to acquire competencies in new fields and prototype functionalities outside their area of expertise. To evaluate the effectiveness of this procedure, we distinguish between use cases. While it can help evaluate general feasibility and functionality, it may not guide design and development or test product acceptance in user interviews due to a limited visual quality. Nonetheless, we anticipate rapid progress in the development of new, specialized AI design tools that can create prototypes with both conceptual depth and high-quality

design and render obsolete the better part of manual digital prototyping in early phases.

Third, our experiences show that LLMs ask for a rethinking of the way human innovation teams purposively and effectively interact with AIs and integrate them into their workflows. Human teams often use LLMs as a jump start in the process and build on AI-generated information, correct it, or use it as inspiration for further development. Managers in our projects noted that AI-generated information often resembles a draft version created by a skilled human assistant. The benefit of this approach is that it is easier and less time-consuming to edit a version than to produce the initial thoughts. As a result, innovation methods, such as design thinking, need to be revised to leverage the new opportunities presented by generative AI.

While individuals across the globe are embracing LLMs, organizations and, in particular, nontechnology companies are still in the early stages of tapping the potential of generative AI. The learning curve in most organizations is predominantly based on the experimentation of individuals. Companies may start systematizing their AI efforts by supporting cross-departmental AI initiatives, such as communities of interest, establishing a knowledge management system that supports the AI learning journey, redefining the required skillset and roles of their innovation teams, and developing a coherent AI strategy [10].

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